SPARK

REPORT

STRATEGIC PLANNING FOR APPLIED RESEARCH AND KNOWLEDGE

Science Council of British Columbia

CONSTRUCTION COMMITTEE

PLANNING REPORT

PREPARED FOR

THE SCIENCE COUNCIL OF BRITISH COLUMBIA

NOVEMBER 1988

CONSTRUCTION SECTOR

SCIENCE AND TECHNOLOGY STRATEGIC PLAN

TABLE OF CONTENTS

		Page
EXECUTIVE SUMMARY		
I	INTRODUCTION	1
II	BACKGROUND	
	Size	3
	Nature of the Industry	4
III	RESEARCH AND DEVELOPMENT	7
	Trends and Issues	9
	1. Housing	10
	2. Commercial	11
	3. Institutional	12
	4. Industrial	12
	5. Heavy Construction	13
	6. Infrastructure	14
IV	CONSTRUCTION INDUSTRY ATTITUDES TO R&D	15
	Technology Required by Sector	16
	Technology Discovery	16
	Resources Devoted to Technology	17
	Forms of Technology Transfer	18
V	CONSTRAINTS WITHIN THE CONSTRUCTION INDUSTRY ON THE USE OF R&D	
	1. Inherent features of the industry	20
	2. Current features of the industry that could possibly be changed	21
VI	OVERALL RECOMMENDATIONS	
	1. Raise the awareness and understanding of the use of science and technology in the construction industry	23
	2. Focus the owners on improving cost/effectiveness	24
	3. Review R&D funding arrangements	24
	4. Foster an environment for innovation	24
VII	SPECIAL RESEARCH ACTIVITIES	
	Housing Industry	26
	Institutional	27
	Industrial Construction	27
	Heavy Construction	28
	Infrastructure	28
VIII	IMPLEMENTATION	29

EXECUTIVE SUMMARY

The construction industry includes the supply of all materials, products and equipment for construction, the activities involved with the design and implementation of construction projects and the involvement of organizations in the ongoing operation and maintenance of buildings and facilities.

The construction industry is estimated to be 14% of the Gross National Product of Canada and a similar % of the B.C. Gross Provincial Product. It has a very large impact on the economic future of B.C. as its work impacts on all other sectors. The sector has grown at 8.3% per year in the past 10 years and is forecasted to grow at a faster rate than the rest of the economy in the next few years.

The industry is fragmented and the average firm is small and specialized. Large projects are divided up and the whole process is governed by codes, regulations, by-laws, specifications and the bidding process. These inherent features of the industry coupled with an absence of profits over the last 5 years, has led to a very low effort in R&D. The sector is one of the lowest in terms of % of gross revenue spent on R&D with an average of .11% compared to 1.4% for Canada overall and 0.7% for B.C.

The major overall recommendations of the committee focus on:

- raising the awareness and understanding of the use of science and technology in the industry
- focusing the owners on improving cost/effectiveness
- reviewing R&D funding arrangements
- fostering an environment for innovation

In addition, the committee has identified specific research initiatives in:

- Housing
- Institutional
- Industrial
- Heavy Construction
- Infrastructure

The committee outlines a plan for implementing the recommendations that involves a major province-wide 'kick-off' to raise awareness of R&D in the construction industry; the assignment of a full-time resource to pursue the recommendations; the continuation of the sector planning committee; its role as a committee of Science Council for AGAR Grants; the identification of a test project for innovation; and the development of a storefront facility to foster technology transfer.

I INTRODUCTION

The Science Council of B.C. developed a revised mission statement in January 1987 focussing its attention on the application of science and technology to the economy, utilizing the community of scientists and engineers in the province. In order to pursue this mission, it embarked on a series of sector strategic plans for science and technology in the province. One of the sectors that its assistance grants for applied research did not cover was the Construction Sector and it became clear that a plan for science and technology in this sector would be equally important as the other sectors being reviewed. The Canadian Construction Research Board (CCRB), B.C. Chapter was in existence and was utilized as a base for this activity. The members of the committee were:

Roger Woodhead - Chairman
Dillingham Construction Ltd.

Allan Bennett
Amalgamated Construction
Association of B.C.

Fred C. Hodges
Discovery Parks Incorporated

Doug D. Lambert

Ted A. Maranda
D.W. Thomson Consultants Ltd.

Chris Mattock
Canadian Home Builders Assoc.

Dennis McJunkin
Willis, Cunliffe, Tait/DelCan

Alan Russell
University of British Columbia

Alan M. Toon
National Research Council

W.H. Curtis
City of Vancouver

Ray Cunliffe
Willis, Cunliffe, Tait/DelCan

Bruce Peter
Canadian Construction Association

Martin van den Hooven

John Witt (Committee Consultant)
Western Management Consultants

The committee used a recent report from the Institute for Research in Construction in Ottawa entitled "The Construction Industry and the Issues Facing It" as a base for much of the information presented in this report. The committee's major task was to add to this report's information the particular issues facing the construction industry in B.C.

Now that this report has been developed, it is the intention to share its information with a broad cross section of the construction industry and those involved in science and technology for that industry in a forum.

II BACKGROUND

The construction industry is defined for purposes of this review as the sector of the economy that spans the supply of all materials, construction products and equipment to the construction industry; the activities involved with the engineering and design of construction projects; the contracting industry and all of its elements that build construction projects and finally those organizations and people involved in the ongoing operation and maintenance of buildings and facilities.

Size

The construction sector of the Canadian economy is estimated to be 14% of the Gross National Product of the country and without having specific information for British Columbia, the committee feels that relationship would be at least similar in this province. For British Columbia, this would make it one of the largest sectors of activity and vitally important to the major industry sectors of the provincial economy. Clearly, the importance of the construction of plant and processing facilities for the forest, mining, agriculture, aquatic resources and energy sectors of our economy is very significant because lower capital costs would tend to lower production costs.

In addition, this sector spans the construction of facilities for the major government activities of health, education and government buildings themselves. It also includes the very large housing sector and the infrastructure of roads and transportation networks, sewer, water, electric, etc.

It has been estimated that a large multiplier effect occurs on the construction sector of the economy in that every dollar spent on construction produces an additional 83¢ of economic activity for a total of $1.83 which is larger than most other sectors.

Significant growth has been experienced by this sector in the period 1975 to 1985. Throughout Canada, that growth rate is at a 8.22% compounded annual rate and in British Columbia, it has been at an 8.51% compounded rate. In the future, it is forecast that it will continue to grow at a rate of 4.4% per year to the year 1990 which will be faster than the growth rate forecast for the rest of the economy. However, this overall growth rate is forecast to decline somewhat after 1990 based on the demographic trends in the population.

Nature of the Industry

The industry is a fragmented activity in Canada and in British Columbia. The average firm is small and specialized and this fragmentation and specialization is expected to increase in the future. This fragmentation has been encouraged by the government's policy of dividing up large projects to allow smaller firms the opportunity to bid on them and in addition, taxation changes have reduced the profitability of rental developments discouraging the large contractor or developer. The open tender system favours small specialized firms. The bidder willing to take the biggest financial risk, all other things being equal, wins the contract. This system lends advantage to the small operator who has a smaller overhead and less dependence on a steady stream of business.

The disadvantage of this trend is the lack of cohesion in the construction industry. It is seriously fragmented in its overall organization and operations reducing the quality of communication amongst its components.

There has not been a major element of export activity in the contracting part of the construction industry because of the fragmentation of the industry and the sparsity of large organizations able to bid on overseas projects. There has been significant overseas activity from architects and engineers in the design phase, however the percentage of work done by architects overseas is small, 2.5% of their revenue with 35% of this in the U.S. With consulting engineers, they have won 20% of their revenue in foreign markets which represents 8% of the total foreign market which is a significant aspect to be considered.

Productivity is a major factor for the construction industry and much attention is focussed on ways to improve this productivity as it has a large bearing on the ability of the owners to maintain their relative position in their industry. It has been recognized that technological innovation and technology transfer are important elements in the productivity aspect of the industry and although these have received considerable focus from N.R.C. through other national reviews, the industry itself is not yet a major user of technology and research and development.

The following table illustrates the nature of construction investment in Canada by structure type, forecast through to 1995:

BREAKDOWN OF THE CONSTRUCTION ACTIVITY IN CANADA

Construction Investment by Structure Type (millions of 1971 dollars)

Structure Type	1986	1987	1988	1989	1990	1995
			Levels			
Total Investment	18,477	19,245	20,679	21,303	21,540	23,679
Buildings - Total	10,752	11,127	11,617	11,769	11,787	12,110
Residential	5,715	5,754	5,811	5,777	5,646	5,169
Commercial	2,546	2,711	2,952	2,966	2,982	3,459
Institutional	1,084	1,063	1,076	1,079	1,087	1,155
Other	598	646	693	730	754	850
Engineering - Total	7,725	8,118	9,062	9,534	9,753	11,569
Marine	145	159	176	184	193	198
Road, highway, runway	1,308	1,474	1,750	1,823	1,886	1,944
Water and sewage systems	806	895	1,057	1,059	1,085	1,159
Dams and irrigation	89	95	105	108	111	117
Power	1,283	1,382	1,544	1,667	1,591	1,965
Railway, telephone	588	652	730	728	673	977
Oil and gas	2,601	2,478	2,618	2,788	2,981	3,844
Other	906	983	1,082	1,175	1,234	1,364
Total nonresidential investment	12,763	13,491	14,867	15,526	15,894	18,511

Source: Informetrica Ltd., Provincial Construction Outlook to 2005, June 1986.

III RESEARCH AND DEVELOPMENT

Some information is available about the activities involved with research and development in Canada which are largely spearheaded by the Institute for Research and Construction and its various interfacing industry committees and full time resources in the province. It has been estimated that the total dollars spent in Canada on research and development in construction are approximately 0.11% of the total gross revenue related to this industry. This level is very low compared with other countries. The overall Canadian average expenditure on R&D is 1.4% of the Gross National Product; it is .7% of the Gross Provincial Product in British Columbia.

The major countries with whom Canada competes, mainly the U.S., West Germany, Japan, Sweden and the U.K. are spending in the area of 2.5% to 3.0% of their Gross National Product on R&D. Therefore, we can see that in Canada, this industry, which is such a large percentage of our economic activity, is probably one of the lowest in its focus on research and development. This low level of R&D is even more significant in terms of research and development and even more significant, in terms of transferring technology to the user because of the large number of small companies in the industry and the high cost of transferring technology to them.

As far as British Columbia is concerned, the committee estimates that if anything, the percent of the construction revenue in British Columbia spent on R&D would be even lower than the national average of 0.11%. One way of measuring the amount of research and development is to look at the organizations

involved with research and development in this province and to understand the extent of their involvement in construction research and development. The Science Council of B.C. has an annual budget of $3.8 million a year which it uses throughout all industry sectors for grants for applied research and scholarships for people involved with applied research. It has not had a sector committee focussing on the construction industry and has distributed very little of its funding towards this sector.

The University of British Columbia is involved with construction engineering and management; geo-technical research; heavy equipment research; materials developments; offshore engineering; structures; and transportation. This activity involves some 38 projects in the $10,000 to $100,000 range and 6 projects over $100,000 during the period 1987 and planned through to 1990. Approximately 22 faculty researchers are working in these respective areas.

In addition, B.C.I.T. administers a number of technology transfer programs in the construction industry and the University of Victoria is involved in the CAD/CAM area. In addition, at SFU, expert systems are being developed, some of which may be used in the construction industry.

There is no specific laboratory or research institution focussing on the construction industry in this province similar to those involved in the forest industry and agriculture. There is not presently an overall plan for science and technology in the construction industry in B.C. nor a picture of the

private sector companies and the extent of their research and development activity. However members of the committee believe that this is not extensive at this time and therefore they draw the conclusion that the total value of R&D activity in the province is likely to be lower than the .11% indicated on a national level.

In other countries, research and development activity in the construction industry is more significant, particularly in Japan where large laboratories and expenditures by private sector companies are common and significant dollars are spent investigating new materials for construction and new techniques in particular aspects of the industry. This endeavour is regarded as a major factor in making the Japanese construction industry a major player in the export market. In the U.S., considerable activity is expended in research, particularly in the housing sector.

Trends and Issues

The committee has divided the construction sector into the following sub-sets for purposes of discussion of the opportunities for technological innovation in British Columbia.

Housing
Commercial
Institutional
Industrial
Heavy Construction
Infrastructure

Looking at each of these sectors separately, we will describe the current trends in those sectors and the opportunities for research and development.

1. Housing

This is a major sector of construction activity and embraces single family dwellings, the renovation of housing stock and multiple family dwellings and highrise apartments. It is also a very important sector in regard to British Columbia as it is one of the major users of the B.C. forest industry's products and provides an opportunity for interaction between the housing industry and the forest industry in the development of new products and techniques which can then be exported on a worldwide basis. In 1988, housing construction and renovation accounted for $3.6 billion of the B.C. output which places it in the top few contributions to the Gross Provincial Product.

This sector has seen an increase in multiple housing units, particularly in the retirement housing area which is a growing sector and also in high-rise apartments.

Major concerns in the housing sector are related to reducing the cost and therefore the price of housing which is becoming too expensive for many segments of the population. This reduction applies not only to construction costs but also to the price of land where government restrictions on land use are driving up the price of residential lots.

The specific areas of interest to the housing sector are air quality including ventilation, standards for combustion and radon gas, truss uplift in wood frame construction, the use of computers and CAD technology and the opportunities for prefabrication of manufactured homes and further opportunities to replace imported equipment and products into this sector. Opportunities also exist following free trade for suppliers of equipment and materials to the housing industry to provide these supplies to the U.S. market.

2. Commercial

This sector is identified as having predominantly larger organization units than the other construction sectors and has many international development companies based in this province. The major area of concern is the fact that commercial properties are built for a developer who does not usually retain the property through its lifetime but sells it quickly to an owner who operates it. Therefore developers are interested in reducing the costs of their product and this allows opportunities for innovation which are aided by the fact that most developments are negotiated rather than bid. This allows the contractor to offer advantages of building faster and cheaper. The attractiveness of appearance is also important to these commercial properties. Many of the technological innovations started in this sector could be transferred to other construction sectors where the environment may not be as appropriate for innovation and research and development.

Specifically, the opportunities are for systems R&D, information technology inputs and productivity improvement. Many of these improvements would be exportable outside of the province.

3. Institutional

This sector of the construction industry focuses on an owner who does operate and maintain the building throughout its life cycle. Therefore, the interest is not only in the initial cost and the speed of construction but also in the life cycle cost of the property. Opportunities exist here for technological improvements in energy consumption and control systems and indoor air quality and heat recovery systems and in earthquake engineering. There is an interest in reducing the operating and maintenance costs of the property and in reducing potential liability concerning the buildings. There may be an opportunity in this sector to test innovative ideas as the client is the government and it could see an advantage in financing research and development for its own benefit which could then be transferred to other construction sectors.

4. Industrial

This sector covers processing plants that are used by B.C. industry, it does not include warehousing which is included under the commercial sector. Its main activities involve production plants for the mining, the pulp and paper, the forest products, and the petrochemical industries. It is characterized by a boom and bust cycle which causes labour to leave during the slow periods who are very difficult to replace during the boom times. It is also characterized by its focus on remote sites that often have severe climates and involve high costs in moving materials and labour. In addition, many of these plants produce an aggressive, corrosion environment.

In the U.S., the owners have driven the construction industry to be more efficient because they wish to keep their costs down to remain competitive. They also wish to have their plants available for use quickly as the cost of loss of production is very large on a day by day basis. Possible areas for research involve modularization, mitigating the impact of severe climate and the training of construction personnel and owners in terms of their willingness to accept technological improvements. There is often a major shortage of labour for these types of projects in British Columbia and this problem is impacted by the union/non-union situation as most of the industries involved as receivers of these plants are unionized.

5. Heavy Construction

This sector deals with all construction other than buildings and includes construction activities on roads, railroads, airports, bridges, dams, river works and flood protection. There is little opportunity for the construction sector itself to deal with research as they generally respond to plans and specifications prepared by others. In addition, extensive research is carried out by equipment manufacturers and by material suppliers which in turn is marketed to both the design fraternity and to the users, the heavy construction contractors.

The Heavy Construction Industry in British Columbia is pressing the Ministry of Transportation and Highways for adoption of a policy which encourages value engineering. Value engineering is a system whereby a contractor can be rewarded for proposing an alternate method of solution to the

owner's requirements. Value engineering will no doubt lead to more innovation being sought by the heavy construction contractors which will lead to more research and development of new techniques.

6. Infrastructure

This major area of concern in North America deals with the maintenance and replacement of infrastructure, both urban and rural, such as roads, bridges, sidewalks, sewer and water systems. The backlog of work required to bring the urban portion of these facilities to acceptable standards would cost about $15 billion for Canada and about $1.5 billion for British Columbia. If rural facilities are added, the cost is considerably higher. Of the above types of infrastructure, roads and sidewalks are in the greatest need of attention.

The major problem is lack of funds for this activity, however some R&D issues are involved and British Columbia has played a prominent role in the Canadian and North American reviews of this problem. It will be essential that research into these areas be coordinated on a North American basis and that British Columbia play its part in undertaking projects that would be utilized across North America. It would then have access to similar research performed in other areas.

IV CONSTRUCTION INDUSTRY ATTITUDES TOWARDS R&D

There presently does not exist a strong focus on R&D in the construction industry in British Columbia. This is partly the result of very poor financial results in the past five years which has meant very little funding available for R&D and most of the management attention of the companies having to be involved with survival. However, many companies are now recognizing that some further uses of science and technology are required and that efforts are needed to bridge the gap of undertaking the research and then transferring the technology to the very large number of small companies that are involved in this industry. There is a lack of awareness of both the success stories related to science and technology in the industry and also the availability of funding to assist with the research and development that is required.

A recent study was undertaken for the construction industry in British Columbia by the National Research Council. The survey was based on interviews with approximately 300 companies representing the various associations involved:

- Architectural Institute of B.C. (AIBC)
- Amalgamated Construction Association of B.C. (ACABC)
- Consulting Engineers of B.C. (CEBC)
- Canadian Home Builders Association of B.C. (CHBA)
- Road Builders of B.C.

The following items are extracted from the Executive Summary of this report.

1. Technology Required by Sector

General areas are: computer systems, prefabricated components, and composite materials. More specifically, the sectors individually want the following new technology: AIBC - waterproofing systems roofing and vapor barriers. They want unbiased information on all materials and methods, including the building envelope. ACA - welding, building envelope, water proofing, and ventilation. CEBC - databases for information on design data and literature sources. CHBA - ventilation equipment and requirements, toxicity of materials, any new technology that is related to changes to be made to the National Building Code. Of substantial importance is a source of well trained trades people. Manufacturers (CHBA) - keep up with European trends and technology.

Of major concern for most companies is not what new technology they will be adopting, but whether their employees are adequately equipped to utilize the technology and if clients will readily accept it.

2. Technology Discovery

New technology is often discovered by:

1) Watching the competition.
2) Salesmen from manufacturers and suppliers keeping the firm informed.
3) Client demand i.e. a client will specify the new technology required.
4) New students hired.
5) Journals.
6) Word of mouth - especially for general contractors (even more for CHBA general contractors) but also important for CEBC and AIBC.

7) In-house R&D - especially true for CHBA.
8) Parent Companies - especially true for manufacturers and suppliers.
9) Through CHBA - for subcontractors and general contractors.
10) NRC - for architects and CHBA suppliers.

New technology is adopted at the time that:

1) It can be financed.
2) It is perceived to be cost efficient.
3) The client demands it.
4) Head Office makes the decision.

Most technology is adopted through the supplier. Many firms are, however, not supplied with the proper training to make their systems efficient or cost effective. Proper training is often not taken into account when new technology is adopted.

3. Resources Devoted to Technology

Much of the technological development that takes place in the construction industry is client driven. Most technological innovations exist long before they become commonly used in the construction industry. It is only through client demand that it comes into common use. The clients will only create this demand when they are thoroughly convinced that it will save money. Combined with the traditional nature of the industry and the fact that there is only a relatively small population base here, technological development becomes low in priority to "just getting the job done".

The amounts budgeted for R&D in 1988 indicates that the ACA and AIBC members do not participate in R&D to the degree that the CHBA and CEBC

members do. Participation by the AIBC and the ACA is far below the provincial average of .7%. Of all the companies surveyed more than half do not participate in R&D!

Forms of Technology Transfer

The type of technology transfer that works best is dependent on the subgroup in question. A written form is probably the best for the construction industry on the whole. Journals are probably still the best general method of doing this; they are commonly used to make the industry aware of new technology. Technology transfer of specific information goes from the manufacturer to the supplier and then into the industry via technical or sales representatives.

Architects prefer a written system which can be filed and is easily updated for later reference. Engineers seem to prefer a system where they can obtain initial information in a condensed summary form, and if need be, quickly obtain more detailed information. Contractors prefer specification sheets from suppliers, word of mouth is also a very important method for them to receive information.

Computer information systems will rapidly increase in importance, especially for engineers and to a lesser degree for architects. FAX is more directed toward being a communication system, but no doubt, is also used for technology transfer. Possibly, future systems will allow for the combining of FAX with the computer information system to allow for the transmission of

hard-copy or information stored on computer disks. Audio visual methods will also increase in popularity anywhere where visual backup is required. It is ideal for showing the capabilities of new equipment and is also ideal for training personnel on installation procedures or new methods, at a low cost. The telephone will continue to be an important method of technology transfer, as a backup to the other systems, when additional information is required.

Export Potential

Exports of services and products do not presently represent a large part of the B.C. construction industry activity. The committee beleives that there are opportunities for B.C. design, engineering, project management and specialized product sales overseas. These opportunities, along with the longer term possibility of selected construction packages being marketed, will require a concentrated focus for the B.C. industry and coordination with organizations such as C.O.F.I. and the Asia/Pacific organization.

V CONSTRAINTS WITHIN THE CONSTRUCTION INDUSTRY ON THE EXTENT OF R&D

The committee identified a number of significant constraints within the construction industry in B.C. that are limiting the extent of research and development. These constraints were identified either as integral and unavoidable features of the industry or as matters that should be remedied.

1. Inherent features of the industry

This first set of constraints are viewed as fundamental aspects of the construction industry in B.C. and not likely to be changed significantly by the recommendations of this committee.

- the bidding process which is currently basic to the industry brings a short cycle focus which does not encourage R&D.
- the industry is severely fragmented which does not encourage innovators, as the benefits of implementation do not accrue to the innovator.
- the current lack of vertical integration also discourages innovation because of the number of players who have to be convinced of making changes from the approved drawing and specifications. It is far easier to deliver what is originally specified rather than innovate.
- the contractual and legal obligations which are very well defined also encourage proceeding with agreed work rather than making changes.
- the revision of codes and standards for new materials and approaches is a very protracted process which discourages innovation.
- patent law is cumbersome, expensive and long winded when protecting innovators.
- the rigid manner in which codes and standards are applied detract from innovative thinking.

- there is a pronounced fear of litigation within the industry which causes participants to avoid the new, innovative and possibly risky procedure or product.

- the industry thinks in a project by project mode where lowest bidders survive and not on a longer term developmental basis.

These factors have to be recognized as basic features of the industry, which probably will not change, at least in the short term, and therefore means have to be found to encourage R&D in spite of these features.

2. Current features of the industry that could possibly be changed

The committee identifies here those important features of the industry that could possibly be changed and which would encourage a greater use of R&D in the industry.

- there is a lack of executive training within the senior management groups of the construction companies. There is then an absence of emphasis on market planning, technology assessment and longer term strategic planning. The universities have not yet targeted the construction industry in terms of senior management training and development.

- there is a lack of awareness of the significance of R&D in the industry.

- there is a lack of 'enthusiastic receptors' for innovation. Most people have advanced in the industry on the track record of lowest risk activity rather than being rewarded for innovation.

- there is no one 'umbrella' industry organization to represent all facets of the construction industry discussed in this report.

- the industry is generally unaware of the R&D assistance that is available federally and provincially.

- existing assistance programs do not fund market studies.

- there is a growing shortage of skilled tradesmen. Young people are not currently entering the apprenticeship system in sufficient numbers to satisfy anticipated demands.

- there has been a distinct lack of pressure from the owners of construction projects to utilize science and technology to improve the product, its costs and delivery schedules.

- capital costs are usually separate in the owners minds from operating and maintenance costs. There is a lack of life cycle cost data on projects.

- designers currently have inadequate fees or time to introduce innovation into the project.

- innovation is usually not cost effective in its early stages and there is an absence of any 'first user cost reduction program'.

- there is an absence of any 'test' environment where innovation can be encouraged and monitored. All changes have to occur in the same bid/project world of day to day construction activity.

VI OVERALL RECOMMENDATIONS

Before discussing its specific recommendations the committee identifies the beneficiaries from increased R&D in the contruction industry in B.C. The province overall will benefit from the increased economic activity resulting from a more efficient, cost effective and competitive construction industry with increased ability to compete on a world wide basis. The owners of construction projects will benefit if costs are held down, time frames are reduced for completion and improved products are developed. These businesses will be more competitive and in the case of institutions their costs will be reduced. The replacement of infrastructure will be enhanced if efficiencies are identified.

The architects, engineers, suppliers and contractors will benefit by providing a more worthwhile service to their 'owner/customers' and becoming the source of up to date innovative alternatives. They will be more competitive on a world wide basis and will have a longer term horizon on which to develop their organizations. In order to improve the use of science and technolgoy in the construction industry in B.C. the following recommendations should be approved and implemented.

1. Raise the awareness and understanding of the use of science and technology in the construction industry

- convene a major kick-off meeting with industry, government and research organizations to promote the increased use of R&D in the industry. The Ontario approach has been reviewed. It should now be investigated to determine what progress has been made.
- organize forums, seminars, meetings on specific aspects of R&D.

- utilize the colleges including B.C.I.T. to increase awareness throughout the province.

- use B.C. business journals to spread the word about R&D in the construction industry.

- develop and deliver senior management training programs for construction industry, government, suppliers, architects and engineers on market planning, technology assessment and longer term strategic planning. Encourage the Universities and Colleges to respond to these needs.

- encourage enlargements of trades training opportunities in the province

- investigate a store front facility to communicate innovative approaches to the industry.

- investigate the coordination of industry associations.

- explore the export potential for B.C. design, engineering and construction package services.

2. Focus the owners on improving cost/effectiveness

- arrange meetings of owners of various types of construction projects to discuss their role in pressing the industry to improve costs, delivery and product.

- investigate life cycle costing approaches to encourage an overall view of projects including those with life-time interests in construction projects such as utilities.

- expand the R&D Planning Committee to include owners representing the Urban Development Institute, B.O.M.A., and the utility companies.

3. Review R&D funding arrangements

- create an awareness of existing funding arrangements for R&D.

- investigate means of attracting industry funding for research.

- investigate a first user risk reduction program.

- request a Science Council of B.C. construction committee for AGAR grants; using the CCRB chapter as its base and liaising with national organizations.

- investigate funding mechanisms for the review of alternative, innovative approaches by design teams.

4. Foster an environment for innovation

- investigate the establishment of 'test' projects by the provincial and federal governments where innovation could be tried in a risk reduced environment and with a budget for this purpose.

- investigate ways of offsetting the negative aspects of fragmentation in the bidding and approvals aspects of projects.

- recognize construction companies and owners who do innovate by annual awards and publicity.

- participate in national and international forums and programs (e.g., infrastructure renewal) to bring innovative ideas to the province.

- encourage an Industry/University NSERC chair in construction in this province.

- develop appropriate technology transfer methods to reach the large number of busy, small companies in the industry.

- explore the possibility of construction industry representatives visiting leading countries using science and technology to learn from their experiences.

VII SPECIFIC RESEARCH ACTIVITIES

The committee has identified specific research opportunities in British Columbia in the following sectors:

- Housing
- Institutional
- Industrial
- Heavy Construction
- Infrastructure

HOUSING INDUSTRY

- Methods of improving indoor air quality through improvements in ventilation control exhaust systems; air make up air devices; control systems, apartment systems; heat recovery ventilators and low cost, simple equipment for measuring low air flows.

- Methods of improving indoor air quality through improvements in low cost, accurate, real time radon gas detection, measurement and control equipment.

- Methods of improving indoor air quality through improvements in sealing formaldehyde gas from the house interior atmosphere.

- Methods of improving air leakage test equipment that is less costly and simpler to operate and allows simplified sizing of made up air openings for large capacity exhaust devices.

- Methods of improving general indoor air quality through low cost real time measurement equipment particularly for organic components.

- Methods of improving structural capabilities through improved truss design and lumber grading to minimize truss uplift and improved framing methods and products to minimize shrinkage induced drywall cracking.

- Methods to improve energy conservation through the development of super windows with heat reflective glass coatings and control of convection between glazing and improved insulation materials with simplified on-site testing methods for installed ceiling, wall and floor R values.

- Methods to improve heating systems through integrated space, domestic hot water and ventilation systems and through the development of backdraft proof factory built fireplaces.

INSTITUTIONAL

- Indoor air quality issues including the establishment of acceptable standards and the monitoring of these standards.

  Also included would be the development of air handling and filtering systems to meet such standards and of required monitoring equipment.

- Improved energy conservation measures including energy management control systems.

- Improved life safety systems for high- and low-rise structures.

- Post disaster design considerations for hospitals (earthquake engineering for structural,electrical and mechanical systems).

- Improved building operations processes (to improve life-cycle costs of buildings).

- Improved cost-effective materials for use in the construction of institutional buildings.

INDUSTRIAL CONSTRUCTION

- Methods of improving construction productivity such as better management reporting systems, quality circles improved morale, etc.

- Methods of modular fabrication in major urban centres and transportation to remote sites.

- Improved training methods for tradesmen, construction managers, designers, etc.

- Improved durability systems which would shorten design/construction times.

- Expert scheduling systems which would shorten design/construction times.

- Improved methods of building in the cold northern interior regions of B.C., i.e. use of admixtures for cold weather concrete, cheaper temporary shelters, etc.

HEAVY CONSTRUCTION

- The use of lightweight fill such as hog fuel and styrofoam in embankments over weak soils. This has been pioneered in B.C. and further research would increase the chance of this technology being exported.

- The use of buoyant submerged tubes as tunnels to carry traffic across B.C.'s coastal fiords. Initial work in this area is being done in Norway so B.C. could effectively join this research effort since it has similar terrain.

- At some future time, a fixed transportation link to Vancouver Island will probably be built. Useful research could be undertaken now to facilitate this massive project i.e. technology of floating concrete bridges, deep water anchors, cathodic protection systems, man made islands in deep water, tsunami effects in the Strait of Georgia.

- The use of robotics in such areas as tunnelling, excavation, underway construction.

INFRASTRUCTURE

- Since the infrastructure is deteriorating at a rapid rate it is essential that B.C. municipalities be able to play a role in the deliberations that are currently ongoing to investigate the problem and subsequently participate in the required research activities.

- Improved performance of highways and bridges such as methods of predicting the remaining life of road bases, stability of road bases, more durable surfaces (concrete and asphalt) in aggressive environments such as that caused by road salt.

- More economical methods of refurbishing sewer and water systems so as to defer complete replacement.

- Improved construction of more durable sidewalks.

- Information retrieval systems which can enable smaller municipalities to gain access to solutions developed and used by the large cities.

VIII IMPLEMENTATION

The committee recommends the following steps in order to implement the recommendations in this report:

1. Convene the 'kick-off' meeting suggested with all key government and industry people.

2. Continue the role of the sector committee to monitor and direct implementation. Expand the committee to include representatives of owners association and the utilities.

3. Assign one of the existing personnel involved in assisting the construction industry in British Columbia to be a dedicated resource to this activity and to assist the committee.

4. Coordinate this activity with the other sectors implementing their plans.

5. Fund the coordinator jointly between NRC and Science Council.

6. Establish this sector committee also as the granting committee of Science Council.

7. Establish a storefront to assist in the transfer of technology.

8. Encourage technology transfer within the industry.

APPENDIX A

SYNOPSIS OF CONSTRUCTION-RELATED RESEARCH
FACULTY OF APPLIED SCIENCE, UNIVERSITY OF BRITISH COLUMBIA

SYNOPSIS OF CONSTRUCTION-RELATED RESEARCH,
FACULTY OF APPLIED SCIENCE, UNIVERSITY OF BRITISH COLUMBIA
MARCH 1988

General Area of Research	Sub-Area	Dept.	Project Title	Faculty Researchers	Year of Completion	Funding						
						Source					$	
						F	P	I	D	E	A	B	C
CONSTRUCTION ENGINEERING AND MANAGEMENT	• Risk Analysis • Expert Systems • Productivity • Computer Integrated Construction	Civil	Advanced Planning Technologies for Construction Productivity Improvement	A.D.Russell W.F. Caselton	1988	•						•	
			Advanced Planning Techniques for Construction	A.D. Russell	Ongoing	•						•	
			Advanced Computer Based Management Technologies for Construction	A.D. Russell	1988	•		•			•		
			Data Communications in Construction	A.D. Russell	1987			•				•	
			Expert System for High-Rise Construction	A.D. Russell	1989			•				•	
GEOTECHNICAL		Civil	Earthquake Design in Richmond, B.C.	P.M. Byrne D.L. Anderson	1987		•					•	
			Response of Oil Sand to Stress and Temperature Changes	P.M. Byrne	Ongoing		•					•	
			Response of Piles to Lateral Loads	P.M. Byrne		•						•	
	• In Situ Testing	Civil	Soil Improvement by Franki Tristar	R.G. Campanella	1989	•						•	
			Soil Improvement by Phoenix Vibro-Drain	R.G. Campanella	1990	•						•	
			Prediction of Performance of Pile Foundation	R.G. Campanella	1992		•					•	
			Downhole Seismic Cone for Earthquake Design	R.G. Campanella	1991	•	•					•	
			R&D of Offshore Seismic Cone Pressuremeter	R.G. Campanella	1988	•					•		

KEY TO FUNDING SOURCE: F = Federal; P = Provincial; I = Industrial; D = Departmental; E = External (Overseas or U.S. Funding)
KEY TO DOLLAR AMOUNT: A = Over $100,000; B = $10,000 - $100,000; C = Under $10,000

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FACULTY OF APPLIED SCIENCE, UNIVERSITY OF BRITISH COLUMBIA
MARCH 1988

General Area of Research	Sub-Area	Dept.	Project Title	Faculty Researchers	Year of Completion	Funding						
						Source					$	
						F	P	I	D	E	A	B	C
GEOTECHNICAL (cont'd)	• In Situ Testing (cont'd)	Civil	Resistivity Probe for Evaluating Groundwater Contamination	R.G. Campanella	1989	•						•	
			In Situ Horizontal Stress Measurements - R&D	R.G. Campanella	1991	•						•	
			Probabilistic Site Characterization	R.G. Campanella	1989	•	•					•	
	• Offshore and Earthquake Engineering	Civil	Soil-Structure Interaction During Earthquakes	W.D. Liam Finn	1987					•	•		
			Analysis of Gulf's Molikpaq Structure at I-65	W.D. Liam Finn (Princ. Invest.)	1988	•						•	
			Dynamic Response Analysis of Structures (NSERC/year) ($ Amount is total for 3 years)	W.D. Liam Finn	1991	•					•		
			Probability of Site Liquefaction	W.D. Liam Finn (Princ. Invest.)	1986							•	
			3-D Dynamic Analysis for Nuclear Power Plants	W.D. Liam Finn						•		•	
	• Soil Characterization	Civil	Stress-Strain Relations, Strength and Earthquake Loading Response of Soils	Y.P. Vaid	1989	•						•	
			Static and Cyclic Mechanical Properties of Sand	Y.P. Vaid	1989			•					•
HEAVY EQUIPMENT	• Robotics	Elect.	Telerobot Interfaces for Machine Operation	P.D. Lawrence M.H. Ito P.L. Cottell	1988	•					•		

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FACULTY OF APPLIED SCIENCE, UNIVERSITY OF BRITISH COLUMBIA
MARCH 1988

General Area of Research	Sub-Area	Dept.	Project Title	Faculty Researchers	Year of Completion	Funding							
						Source					$		
						F	P	I	D	E	A	B	C
MATERIALS		Civil	Mechanical Properties and Behaviour of Fibre-Reinforced Materials	R.J. Gray	1989	•						•	
	• Cementitious Materials	Civil	Impact Properties of Concrete	S. Mindess	Ongoing	•						•	
			Impact Properties of Concrete	S. Mindess	Ongoing				•				•
			Fibre Reinforced Concrete	S. Mindess	Ongoing			•					•
		Mech.	Reliability Analysis of Concrete Materials	K. Bury	1988	•							•
OFFSHORE ENGINEERING	• Wave Loadings	Civil	Wave Effects on Offshore Structures	M. Isaacson	Ongoing	•						•	
STRUCTURES	• Analysis	Civil	Seismic Torsional Analysis of Structures	D.L. Anderson	Ongoing	•							•
		Civil	Analysis of Blast Loaded Composite Plate Structures	M.D. Olson D.L. Anderson	Ongoing	•						•	
	• Earthquake Engineering /Structural Dynamics	Civil	Friction Damped Structures	S. Cherry	Ongoing	•						•	
			Vibration Isolated Equipment	S. Cherry	Ongoing	•						•	
	• Reliability	Civil	Structural Reliability of Wood Systems (Background to CSA-086)	R.O. Foschi	1989	•					•		

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FACULTY OF APPLIED SCIENCE, UNIVERSITY OF BRITISH COLUMBIA
MARCH 1988

General Area of Research	Sub-Area	Dept.	Project Title	Faculty Researchers	Year of Completion	Funding Source					Funding $		
						F	P	I	D	E	A	B	C
STRUCTURES (cont'd)	• Timber Engineering	Civil	Visual Grading	B. Madsen	1989	•						•	
			Electronic Grading	B. Madsen	Ongoing		•					•	
			Proof Loading	B. Madsen	1990			•				•	
	• Analysis and Design	Civil	Slenderness of Columns - RC and Prestressed	N.D. Nathan	Ongoing	•							•
			Masonry - Failure Criteria - Concrete Block Masonry	N.D. Nathan	1988	•						•	
			Seismic Detailing - Dependence on Site Conditions	N.D. Nathan	1988	•						•	
	• Precast Concrete - Buildings	Civil	Precast Connections in Earthquakes	R.A. Spencer	1987			•				•	
			Earthquake Response of Precast Buildings	R.A. Spencer	1987		•					•	
			Earthquake Response of Precast Buildings	R.A. Spencer									
			Ductile Precast Connections	R.A. Spencer	1984	•						•	
		Civil	Fabrication/Construction Oriented Steel Design	S.F. Stiemer	Ongoing	•						•	
			Ultimate Capacity Design of Single Shear Plate Connections	S.F. Stiemer	Ongoing	•						•	
			Teacher's Handbook and Self-paced Instruction Kit for Design of Steel Structures with Micro-computers	S.F. Stiemer				•				•	
TRANSPORTATION	• Expert System	Civil	Highway Location	F. Navin		•						•	
			Highway Safety	F. Navin		•						•	

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APPENDIX B

THE ECONOMIC IMPACT OF THE RESIDENTIAL CONSTRUCTION INDUSTRY IN BRITISH COLUMBIA

THE ECONOMIC IMPACT OF THE RESIDENTIAL CONSTRUCTION INDUSTRY IN BRITISH COLUMBIA

Prepared by: B.C. Central Credit Union
Economics Department

May 6, 1988

THE ECONOMIC IMPACT OF THE RESIDENTIAL CONSTRUCTION INDUSTRY IN BRITISH COLUMBIA

EXECUTIVE SUMMARY

Nature of the Industry

- The residential housing construction industry contributes significantly to the B.C. economy both in terms of employment and gross provincial product. The industry is characterized by a large number of independent entrepreneurs operating in a competitive environment.

The Economic Impact - Output

- In 1987 housing starts reached 28,944, the highest level since 1981, and housing starts during 1988 are expected to be higher still.

- The residential housing construction industry is among the largest in the province in terms of output. During 1987 new residential construction expenditures reached an estimated $2.1 billion (including mobile homes). A further $1.5 billion was spent on conversions, improvements, cottages and supplementary acquisition costs.

- Therefore, a total of $3.6 billion was spent on residential construction in British Columbia in 1987.

- The industry contributes close to 6 percent to the total output of the economy.

- The residential housing construction industry is a cyclical industry, partly because of the tendency for residential property to be subject to speculative pressures. As well, the industry is sensitive to the pace of net in-migration, demographic trends and interest rate changes. The impact of these factors on housing construction is illustrated by the volatility in the numbers of housing starts during the past 10 years.

- At the same time, however, residential construction activity is an investment in the capital stock of the economy, and as such contributes significantly to output and economic growth. During the 1980s, for example, business spending in the housing industry improved much more significantly and more quickly than other investment spending. In this way, the housing industry has played a pivotal role in bringing the economy out of the recession.

- The single most important component of the survey of business investment spending intentions for 1988 is housing construction estimated at $4,036 million, or 49 per cent of total investment in the province. This represents an increase of 12 per cent over 1987.

- As the provincial economy is now on the investment spending portion of the business cycle (i.e., the consumer led expansion is waning) the housing construction industry can be said to be one of the major contributing sectors to growth in GDP.

The Economic Impact - Employment

Employment

- There are 72,000 people who work in the construction industry in B.C., but statistics for the proportion who work in the residential construction industry itself, are not readily available. However, it is possible to estimate the number of workers and the value of income they earn from residential construction.

- The residential construction industry directly contributed an estimated $1.3 billion to wages and salaries in 1987. Based on the average weekly wage figures paid in the industry, this means that direct employment in the residential construction industry is approximately 48,900 person years.

- If we only look at new residential construction expenditures of $2.1 billion, the direct person years of employment are an estimated 28,481.

- Following the analysis one step further, these figures suggest that for every $1 million spent in the industry, approximately 14 direct jobs (person years) are created.

- As well as the direct employment and income generating features of the housing industry, there are indirect and induced impacts commonly referred to as the multiplier affect. Spending in the industry creates demand for other goods and services throughout the economy such as transportation, communications, retail services, professional services, etc. This in turn leads to the creation of jobs and expansion of services and products.

- Indirect employment created from new residential construction activity is estimated at 22,151 person years. Including direct jobs of 28,481, this means a total of 50,632 person years in 1987.

The Economic Impact - Tax Revenues

- New residential construction increases the tax base and generates property tax revenues for municipalities. During 1987 it is estimated that property taxes increased by $23.1 million due to the increased residential tax base created by new construction.

- Income tax revenue was also generated as a result of employment in new residential construction. It is estimated that provincial income tax revenue increased $46 million and federal income tax revenue increased $91 million by virtue of new residential construction activity, for a total of $137 million.

- Adding indirect income taxes paid (based on 22,151 person years); provincial revenues rise to an estimated $88 million and federal income taxes to $175 million for a total of $263 million.

- The provincial government's recently introduced property purchase tax also increased provincial tax revenue by an estimated $37 million during 1987 due to new residential construction.

1. Overview

The residential housing construction industry is an important contributor to growth and prosperity in the B.C. economy. Ranking among the largest industries in the province in terms of output, the residential housing construction sector contributed an estimated $3.6 billion to total output in 1987.

As well, the residential housing construction sector is responsible for creating many skilled trade jobs. During 1987 an estimated 48,900 person years of direct employment were created.

The industry is characterized by a large number of small companies and independent entrepreneurs, each specializing in one of the building trades. Housing construction firms operate in a competitive environment for the most part, and each employ less than 10 employees, often on a seasonal basis. As well, a few large development firms have head offices in the province.

While the industry is cyclical, it usually leads economic recovery in the province and plays a pivotal role in that recovery.

2. Economic Impacts

2.1 Expenditures

In 1987, housing starts, the leading indicator of new residential construction industry activity, reached 28,944, the highest level since the boom of 1981. Although estimates of housing starts for 1988 vary among forecasters, the mid-range estimate is 27,000 with projections as high as 30,700. These estimates suggest 1988 will be another strong year for the industry.

TABLE 1

Housing Starts British Columbia 1978-1987	
Year	Housing Starts
1978	28,618
1979	27,345
1980	37,546
1981	41,585
1982	19,807
1983	22,607
1984	16,169
1985	17,969
1986	20,687
1987	28,944
1988[f]	27,000

[f]Mid-range Forecast

Source: CMHC

During 1987 new residential construction expenditures reached an estimated $2.1 billion (including mobile homes) with a further $1.5 billion spent on conversions, improvements, cottages and supplementary acquisition costs.

Total industry expenditure therefore, reached $3.6 billion in 1987. Industry intentions for 1988 suggest the expenditures will reach $4 billion which would be consistent with almost 30,000 housing starts.

TABLE 2

British Columbia
Residential Construction Industry Expenditures
1986-88

	Total	New	Other
		($ billions)	
1986	2.7	1.6	1.1
1987	3.6	2.1	1.5
1988[f]	4.0	2.4	1.6

[f]Forecast

Source: Statistics Canada 64-201

In addition to direct expenditures on housing construction, an expansion of the housing stock leads to significant spillover expenditures for appliances, furniture, decorating materials, landscaping, etc.

2.2 Contribution to Output

Expenditures in the industry contribute significantly to output and employment and can be favourably compared with the contributions made by the mining and tourist industries. Table 3 below presents the estimates on the value of output by major industry sector during 1987 which results in the residential construction industry ranking second for all industries. If only new residential construction activity is included, the ranking is fourth.

TABLE 3

Contribution to GNP by Industry
(Selected Industries)
1987

Industry	Value of Output* ($ billions)
Forestry	$10.0
Housing Construction	3.6
Mining	2.6
Tourism	2.5
Energy	1.5
Agriculture	1.0
Fishing	.7

*estimated

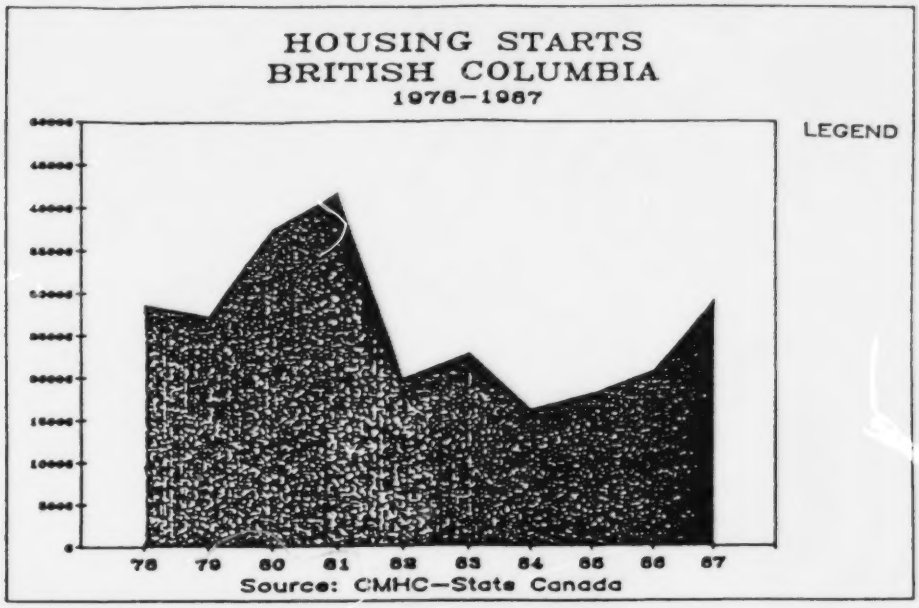
Source: B.C. Central Credit Union

2.3 The Business Cycle and Housing Construction

The residential housing construction industry is a cyclical and volatile industry. This is due to trends in demographics, income, and interest rates, as well as speculative pressures from expectations regarding future availability and affordability of housing. Graph 1, which depicts housing starts over the past 10 years, illustrates the volatility of the industry.

On the supply side, material and labour costs, land availability, taxes (related to construction and sale of completed dwellings) and building code requirements lead to upward pressure on housing costs.

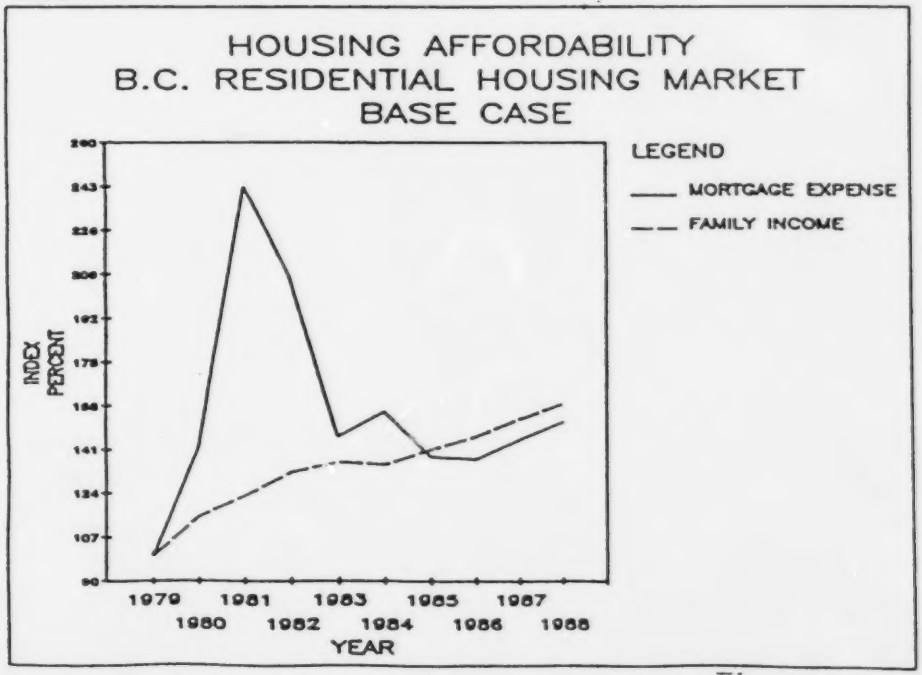
GRAPH 1



As long as houses are affordable, demand remains strong. However, if affordability is threatened by such things as higher interest rates, unemployment, or a rapid rise in property values, demand falls quickly. The industry, responding in a competitive manner, will then cut back dramatically on housing starts.

The affordability index illustrated in Graph 2 is a representation of this situation. In 1985 the affordability of housing returned to pre 1979 levels. It was also about this time that housing starts began to increase and the industry went into recovery.

GRAPH 2

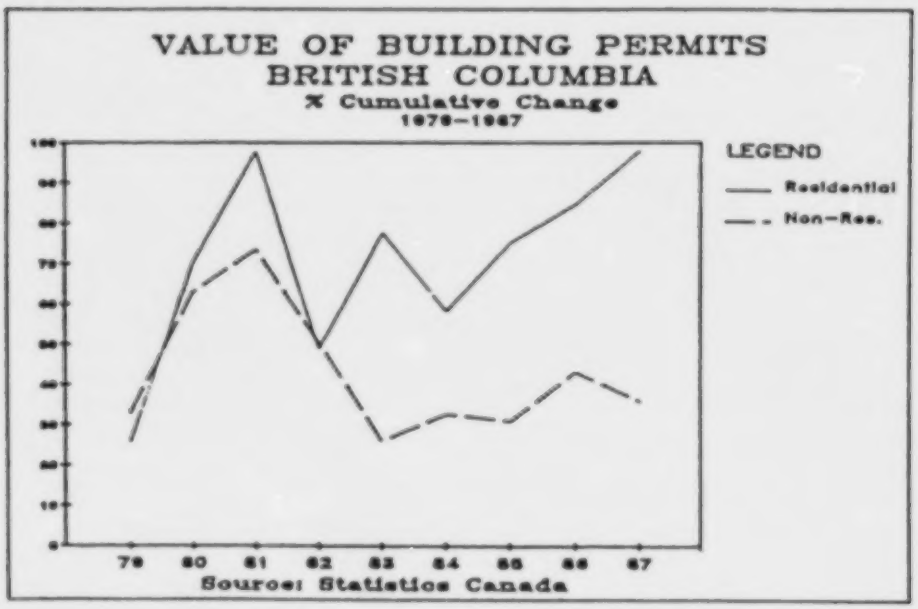


Therefore, although the industry is an important source of strength in the economy, the sensitivity of the market to demand and supply factors can quickly lead to boom and bust cycles.

2.4 Investment Impact

Residential construction activity is an investment in the capital stock of the economy, and as such, contributes significantly to output and economic growth. During the 1980s, for example, business spending in the housing industry improved much more significantly and more quickly than other investment spending. In this way, the housing market has played a pivotal role in bringing the economy out of the recession. Graph 3, which presents the increase in residential construction spending growth compared with non-residential construction spending growth, illustrates this point.

GRAPH 3



The single most important component of the survey of business investment spending intentions for 1988 is housing construction. The estimated amount is $4,036 million, or 49 percent of total investment anticipated in the province during this year. This amount represents an increase of 12 percent over the level reached in 1987.

The provincial economy is now on the investment spending portion of the business cycle as the consumer led recovery is waning. With the strength of investment in the housing construction industry at such a strong level, it is clear that the industry is a major contributor to the anticipated 3.5 percent real growth in GDP this year.

3. Employment Impact

3.1 Employment Creation

There are 72,000 people who work in the construction industry in B.C., but statistics for the proportion who work in the residential construction industry itself are not readily available. However, it is possible to estimate the number of workers and the value of income they earn from the expenditures made in the industry.

The estimated expenditure in the residential construction industry during 1987 was $3.6 billion. Using a labour to material ratio of 36 percent, the industry directly contributed an estimated $1.3 billion to wages and salaries in 1987. Based upon average weekly wage figures paid in the industry, this means that direct employment in the residential construction industry is approximately 48,900 person years.

Looking only at new residential construction expenditures $2.1 billion, the direct person years of employment are an estimated 28,481.

TABLE 5

Total Direct Employment New Residential Construction (1986-88)			
	1986	1987	1988[f]
Total Direct Employment	26,475	28,481	31,911

[f]Forecast

Source: B.C. Central Credit Union

Following the analysis one step further, these figures suggest that for every $1 million spent in the new residential housing construction industry, approximately 14 direct jobs are created.

3.2 Indirect Employment Impact

As well as the direct employment and income generating features of the housing industry, there are indirect and induced affects. That is, spending creates an indirect demand for labour to produce these materials. The induced affect on jobs refers to the employment created in spinoff industries such as transportation, communications, retail services, and other support industries.

Based on multiplier estimates from Canada Mortgage and Housing Corporation, the indirect employment creation from new residential housing construction in 1987 was an additional 22,151 person years of employment for a total of 50,632 person years. An estimate for induced affects is not available.

4. Tax Revenues

4.1 Municipal Taxes

The construction of new residential housing creates an expanded property base for municipalities. During 1987 an estimated $23.1 million in additional property taxes resulted from the level of activity in the industry.

4.2 Income Taxes

Income tax revenue was also generated as a result of new residential construction. It is estimated that people directly employed in new residential construction paid provincial income tax of $46 million and federal income tax of $91 million for a total of $137 million.

If we include taxes paid from indirect employment, total provincial tax revenues were an estimated $88 million and federal tax revenues $175 million, for a total of $263 million.

4.3 Property Purchase Tax

The provincial government's recently announced property purchase tax is applied to all property sales regardless of the stage of construction. As a result, some new residential property is taxed as many as three times before it sold to a residential user. The tax is assessed at 1 percent for the first $200,000 and 2 percent on the remaining value. Although a detailed analysis on the weighted average tax has not been undertaken, a reasonable estimate would place the rate at approximately 1.3 percent. Applying this rate on an annualized basis to the value of new residential construction suggests that close to $40 million would have been paid during 1987.

APPENDIX A

Residential Building Permits British Columbia		
Year	Total	Residential
	($ millions)	
1978	1,655	958
1979	2,134	1,207
1980	2,951	1,744
1981	3,556	2,221
1982	2,161	1,135
1983	2,238	1,463
1984	2,004	1,177
1985	2,190	1,378
1986	2,420	1,508
1987	2,551	1,706

APPENDIX C

THE NEED FOR INFRASTRUCTURE REPAIR
UPDATE OF MACROECONOMIC IMPACT ANALYSIS AND CURRENT STATUS

THE NEED FOR INFRASTRUCTURE REPAIR

UPDATE OF MACROECONOMIC IMPACT ANALYSIS

AND

CURRENT STATUS

THE NEED FOR INFRASTRUCTURE REPAIR

UPDATE OF MACROECONOMIC IMPACT ANALYSIS AND CURRENT STATUS

Infrastructure in Canadian municipalities continues to be in serious need of repair and upgrading. The original survey conducted by FCM in 1984 identified the need to invest $12 billion.

Since then, the need has intensified. As the FCM Big City Mayors' Caucus showed the Cabinet Committee on Economic and Regional Development in May 1987, roads and bridges in Montreal are crumbling, water pipes are erupting in Edmonton, sewage treatment in Vancouver requires $100 million upgrading. And there are many more examples.

Not only is the problem serious, but the repair costs are escalating. As the new Informetrica analysis shows, new taxes and inflation, alone, have raised the $12 billion to $15.3 billion. However, $15.3 billion likely underestimates the current need since infrastructure deteriorates and costs escalate at increasing rates over time.

The original macroeconomic impact analysis done by the econometric firm Informetrica was re-run in October. In addition to adjusting the original figures for inflation and new taxes, the re-run was necessary because the econometric model of the economy originally used has been updated and refined, particularly the section on labour markets. As well, the assumptions that went into the original computer run needed updating. For instance, long term interest rates have risen from approximately eight per cent to ten per cent currently.

Economists representing three major Canadian consulting firms reviewed both the model and the assumptions. One improvement these economists brought to the analysis was to run the impact analysis to ten years from the five years used originally. This was done because the impact of the infrastructure repair investment will continue to work its way through the economy after the program ends.

The new run confirmed the earlier analysis. The following chart shows the comparison between the old and new runs.

Comparison of Results
No Interest Rate Impact

	Five-Year Impact			Ten-Year Impact		
	Interest Rate	Employment (000 p-y)	Federal Deficit ($Mn)	Interest Rate	Employment (000 p-y)	Federal Deficit ($Mn)
1985	0.0	285	+81 INCREASE	------not done-----		
1987	0.0	314	-416	0.0	376	+3772 DECREASE

The employment generated is even greater than previously due to the refinements made in the labour market section of the model. The very small increase in the deficit after five years, rather than an actual reduction in the original, is due to the two per cent increase in interest rates. Over ten years, the labour impact is even greater and a substantial deficit reduction occurs.

The Minister of Finance argues that the North American capital market will not be able to absorb $3 billion a year of new borrowing for five years without interest rates being forced up. One might question this assumption given the recent example of the G7 pushing interest rates down 1.5 per cent in response to the stock market crash. In addition, economic theory is ambivalent about what the effect on interest rates will be.

Nonetheless, we must address the Minister's concern if we wish to change the current federal government stance. Using the Bank of Canada interest rate adjustment model and assuming all three governments borrow, the analysis was rerun. The results are in the table below.

Comparison of Results
Interest Rates Rise
All Governments Borrow

	Five-Year Impact			Ten-Year Impact		
	Interest Rate	Employment (000 p-y)	Federal Deficit ($Mn)	Interest Rate	Employment (000 p-y)	Federal Deficit ($Mn)
1985	----------not done------			-----not done------		
1987	.22	273	-4924	.05	323	-871

The interest rate increase affects both employment and the deficit. Less, but still very substantial employment is generated over both five and ten years. In five years, the budget deficit is increased substantially. However, as the investment continues to generate growth over the subsequent five years, the final deficit increase is a moderate $871 million.

A third alternative was run which assumes interest rates rise, that the federal and provincial governments borrow and that municipal governments raise 90 per cent of their share through a combination of higher taxes and user fees, and 10 per cent through debt. This results in a smaller interest rate impact and, as a result, smaller deficit increases, but also slightly smaller employment generation.

Comparison of Results
Interest Rates Rise
Municipalities Increase Taxes and User Fees

	Five-Year Impact			Ten-Year Impact		
	Interest Rate	Employment (000 p-y)	Federal Deficit ($Mn)	Interest Rate	Employment (000 p-y)	Federal Deficit ($Mn)
1985	.28	222	-6311	-----not done------		
1987	.16	262	-3250	.04	294	-100

We will require direction from elected officials as to which of these methods of financing the municipalities choose to use.

Two new developments reinforce the need for the FCM Infrastructure Repair Program. Many economists, including those at the Bank of Montreal and the C.D. Howe Institute, are predicting a serious recession. The stock market crash has generated even more concern. Further, the prospect of the United States raising taxes during an economic downturn could make a recession even more severe. The traditional federal government response to serious recessions is to introduce large capital works programs as a countercyclical measure.

Infrastructure Repair would be an excellent countercyclical program. It is national in scope; generates substantial employment at relatively low cost; uses mainly Canadian supplies and equipment; and effects a large number of sectors of the economy. The federal government would be well advised at the least to work with FCM and the provinces to be prepared if recession does come.

Secondly, the Infrastructure Repair Program will be even more urgently needed if a free trade agreement is reached with the United States. With open access to both the Canadian and U.S. markets, investors will be able to locate new plants and businesses in either country. One of the key factors that will influence their location decision is the quality of life a municipality offers. Canadian municipalities have a substantial comparative advantage now and, as a result, will probably attract considerable new investment. With deteriorating infrastructure, this comparative advantage will be lost and the country as a whole will suffer.

APPENDIX D

STATE OF URBAN INFRASTRUCTURE IN CANADA

STATE OF URBAN INFRASTRUCTURE IN CANADA

William H. Curtis, City Engineer
City of Vancouver
Chairman, FCM Technical Committee on Infrastructure

A Paper Presented to the First Canadian Conference
on Urban Infrastructure Renewal
Toronto, Ontario
February 5, 1987

INTRODUCTION

In 1984, the Federation of Canadian Municipalities (FCM) carried out a survey[1] and study of the infrastructure problem in Canadian urban areas. A large number of responses from officials across Canada formed the basis for an assessment of the problem. The appendix of this paper contains the conclusions and recommendations of that study. Very briefly, these identify the problem of a rising backlog of necessary infrastructure rebuilding, estimate costs to bring infrastructure back to acceptable levels, suggest intergovernmental co-operation to raise necessary additional funding, outline steps which would reduce costs and improve efficiency, suggest a review of priorities, and call for steps to increase public awareness of the problem.

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(1) Technical Committee on Canada's Urban Infrastrucuture, Canada's Urban Infrastructure - Physical Condition and Funding Adequacy, FCM, (June, 1984).

This paper highlights some of the major findings of the FCM study, but, since most participants in this conference are probably familar with the study, most of the paper is devoted to what has happened since the FCM adopted the recommendations, progress to date in the various parts of Canada, and problems being encountered in carrying out the recommendations. The paper also presents some suggestions on how the obstacles being encountered can be overcome and what the next steps should be in solving the urban infrastructure problem.

WHICH PUBLIC FACILITIES REQUIRE ATTENTION?

In reviewing the condition of existing urban infrastructure, similar results have been obtained from surveys and studies in the United States, Europe, and Canada. It is clear that throughout the western world a backlog of necessary rebuilding works has grown to unacceptable levels. Generally, the facilities which are in the greatest need of attention are roads, bridges, sidewalks, followed by sewer collection systems and water distribution systems. In Canada, something like 70% of respondents to the FCM survey identified roads and bridges in their areas as being the facilities in the worst condition. Subsequent studies, such as the Union of B.C. Municipalities' study for B.C.[(2)] involving smaller municipalities, have reaffirmed these conclusions. Other public facilities such as parks, recreational facilities, community centres and daycare centres have been found to be in generally better

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(2) Union of B.C. Municipalities, British Columbia's Urban Infrastructure, An Extension of the National FCM Survey and Analysis of Urban Infrastructure - 1984, March, 1985.

condition, with most communities reporting the situation as being acceptable. In looking after infrastructure, clearly there has been a shift in emphasis from the basic, non-glamorous needs to other, real, but less fundamental, needs. It is also true that some facilities, such as daycare centres, are in good condition because they are relatively new. Municipal governments did not provide these at all in the first half of the century.

COSTS OF CORRECTION

In Canada, the FCM studies estimated that the cost to restore existing facilities to reasonable levels is about $12 billion (1984$). This is a cost of about $700 per person on the average and, when looked at in terms of Municipal budgets, represents a 25% increase in public works budgets or a 7% increase in total Municipal budgets for a period of 10 years. This assumes the continuation of virtually no contributions from the Federal government and limited contributions from Provincial governments. Since then, the FCM has suggested a 1/3-1/3-1/3 sharing of this funding requirement and, should that occur, Municipal costs would go down dramatically, perhaps, to something like a 2-3% increase in budgets. Even if Senior government shares were half that amount, the remaining local government share would be achievable in most cases.

CAN COSTS BE REDUCED?

Costs cannot be reduced to the extent that additional funding is no longer required. However, the FCM study and subsequent work has shown that, to some extent, costs can be reduced and other revenue sources found. First, public taste for elaborate and expensive facility treatments, which has grown in the past 15 years, makes infrastructure renewal more costly. The ability of the public to press for such treatments, through very much increased public involvement, has contributed to these costs. Without eliminating public involvement, it is possible to resist these pressures and, thereby, reduce cost of renewal.

Elimination of delays in correcting problems can also reduce costs. For example, where a standard roadway has deteriorated and must be replaced and the community demands a gold-plated, attractive treatment far in excess of the standard throughout the rest of the area, considerable delay can occur (often 2 years or more). By the time the work is finally undertaken, deterioration is advanced to such a degree that complete rebuilding is necessary, rather than the less expensive correction. It is necessary not to let expectations build up for elaborate works until the general renewal of all facilities has been completed, at least to standard levels of treatment. Cost savings are possible in this way.

Associated with this is the possibility to save costs through technical efficiency improvements. Generally, these are again associated with standardized treatment and automated mass production techniques. Much was done in this connection during the past two decades, and opportunities for further cost savings in this direction are limited, but possible.

Finally, there is room for greater reliance on user-pay techniques, and other approaches of this sort are possible and are described in technical reports[3] available on this subject. Some have been successfully used in the U.S.A. Although total cost is unchanged, these devices can reduce direct government costs, and the FCM study supports their increased use.

All of the above techniques can be used to assist with the cost problem, but they, alone, will not be enough. Even if all of the cost-cutting techniques could be achieved and even if senior government cost sharing were brought back up to the highest levels that ever existed, additional funding would still be necessary to solve the problem. This additional funding must be found by all levels of government and that is one of the major recommendations of the FCM study.

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(3) Proceedings of the Institute of Transportation Engineers District 6 and District 7 Joint Annual Meeting, Vancouver, B.C. Canada, July 27-31, 1986.

ARE THE FCM RECOMMENDATIONS BEING IMPLEMENTED?

All levels of government have reacted to the FCM studies, and there is a genuine effort to address the problem, particulary at the local government level. Although there has been some progress, which is outlined in more detail later, generally, the recommendations are far from implemented and progress is very slow. Many of the original causes of the problem remain. They and other obstacles being encountered are working against a solution of the problem in a reasonable time frame. Perhaps, it would be useful to review these and see what might be done about them.

FACTORS DETRIMENTAL TO RESOLUTION OF THE PROBLEM

There are several general classes of obstacles which must be overcome to solve the problem: awareness of the problem, co-operation among governments, and others.

Awareness of the Problem

Before any problem can be solved, we must be fully aware it exists and understand it reasonably well. It is true that public awareness has been increased a great deal, but the public's understanding of the problem is still far from perfect.

One factor which contributed to the problem is that public works facilities, once installed, tend to be taken for granted and forgotten. This is understandable as many of them are underground and out of sight. There is little political glamour associated with their renewal. The tendency to favour new works over rebuilding remains at all levels of government.

Another obstacle is that there is still the tendency by many to view the infrastructure problem as an incomprehensible and unsoluble problem, such as the world population explosion or the nuclear threat. The result is that many, who could do more, pay lip service, then relegate the problem to the back burner for possible consideration after all problems of the universe have been solved. In fact, if action is taken reasonably soon, the problem is manageable by the three levels of government. With cooperation, it should be possible over a reasonable period of time to cope with the rebuilding of infrastructure, without unreasonable budget increases. The sooner we begin to address the problem, the easier it will be to cope with it.

On the other hand, some tend to view the problem at the other extreme of the alarm spectrum. Judging from press coverage in some areas, the situation is catastrophic. Bridges are collapsing, people are being killed and water systems are flooding large parts of cities. In reality, throughout the western world, the situation is <u>not</u> catastrophic. Rather, there has been a slow, creeping, neglect which has continued for a long time and could continue

for a while yet. Granted, there are examples in Canadian urban areas, as for example Winnipeg, where water systems have reached a state that the number of breaks per day is at an unacceptable level. In Vancouver, recently, a break in a major old water main necessitated the boiling of water in the entire City. In other areas, some bridges are no longer usable. By and large, however, the deterioration is more subtle, but very wide-spread. A few municipalities have already reached the point where all known funding systems are inadequate to cope with the problem. Should the situation be permitted to continue, many more municipalities could enter this category and then the problem could become unmanageable. This point has not been reached yet.

At the local level, there is a tendency for officials to say "we don't really have as bad a problem here. I was just in such and such a City, and they are in far worse shape". This type of attitude is a significant obstacle to renewing the infrastructure. Certainly, one can always find some other City that is worse off, but this does not deal with the fact that a backlog of necessary work is building up in your own City. The following case study in Vancouver illustrates this problem. It has been found that infrastructure needs overall in Vancouver are not as great as the average need in Canada. In fact, needed expenditures per capita are only about 2/3 those of the average Canadian City. Some have interpreted this to mean Vancouver has no problem and need not have any special programs.

(SLIDE PRESENTATION)

From the slide presentation, it can be seen that the lack of a sidewalk renewal program has resulted in a significant backlog of work, which can now be addressed only through substantial outlay of funds for a prolonged period. The choice now exists between starting to rebuild the sidewalks and pulling money away from other needs, or, letting the sidewalk backlog continue to grow, or, finding large sums of money to do both.

Economic Difficulties and Co-operation Between Governments

During the past decade and more, inflation and interest rates were at such an incredible level there was extreme reluctance to borrow money. Many Directors of Finance pushed the concept of "pay-as-you-go". This meant financing all works from direct revenue in the form of mill rate increases and not borrowing at all. It was a concept comparable to totally eliminating mortgages for homes and, of course, proved unworkable and failed. Unfortunately, even though interest rates and inflation are now considerably lower, similar pressures continue. I recently read a paper from a major Canadian City expounding the virtues of pay-as-you-go and proposing the virtual elimination of all borrowing. Although debt must not be permitted to grow unreasonably, borrowing has always has been and must always remain a reasonable part of our funding structure. Otherwise, there is little hope that we will solve the infrastructure problem.

A contributing factor to the infrastructure problem was the termination, by both the Federal and Provincial governments throughout Canada, of assistance programs such as winter works, capital programs, employment programs, and Provincial revenue sharing programs. Although the condition of urban infrastructure has always been primarily the responsibility of Municipal government, the assistance of senior governments has been significant, contributing perhaps up to 25% of the cost of new facilities. This left more money for infrastructure maintenance and rebuilding by the Municipal governments.

Today, at the Federal and Provincial levels, existing large deficits are obviously a very real concern, and there is a great reluctance by these governments to assume responsibility for rebuilding urban infrastructure facilities for fear of increasing the deficit. However, studies[4] by the FCM and others have demonstrated that infrastructure renewal is a very labour intensive endeavour and can significantly increase employment with spin-off effects on the national economy. Similarly, infrastructure renewal can directly improve the economic viability of commerce and industry, thereby generating increased national revenues which can reduce deficits just as effectively as can restraint. However, the reluctance remains, and continued attention to this is required.

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(4) Mark Haney, Carl Sonnen, The Macroeconomic Impact of Accelerated Spending on Municipal Infrastructure, Informetrica - FCM, March, 1985.

At the same time, local governments, in these continuing times of restraint, are tending to shift responsibility to the senior governments because their limited revenue sources are hard pressed in meeting their responsibilities. There is some justification for this in that some senior governments have virtually terminated cost sharing and grant arrangements, and they should be re-instituted. However, even if cost sharing of 1/3 each from the Federal and Provincial governments were obtained for all programs, there is still a great need for funding increases at the municipal level. Municipalities will simply have to bite the bullet and raise the necessary funds to stop the deterioration of our essential infrastructure and, although urban infrastructure is primarily the responsibility of local government, reasonable assistance from the Federal and Provincial governments is necessary to cope with the problem and should be forthcoming. Passing the buck will not solve the problem. All levels of government must be involved.

Cooperation between the three levels of government in trying to solve the infrastructure problem is far from perfect. For example, Federal and Provincial Departments of Environment have created pollution control acts which make sewer treatment and discharge facilities, that were constructed long before their enactments, now illegal. The Greater Vancouver Regional District was recently found to be in violation of Federal and Provincial acts and ordered to extend a sewer outfall to deep water immediately, at a cost in excess of $50 million. Over 90% of this cost must be borne by the City of

Vancouver, and this has significantly diverted funds from other pressing infrastructure renewal needs. Even though the expenditure is a direct result of new senior government acts and requirements, senior governments have refused to share in the cost. If senior governments wish to raise the national level of environmental protection at this time, they should provide the necessary funding to do so. It is unreasonable to expect local government to assume these very large costs alone.

Recently, the Federal government announced it intends to strengthen pollution control legislation significantly. Strict enforcement, even of existing environmental legislation, could have a profound effect on local government costs which could aggravate the already serious infrastructure renewal problem. In fact, I would guess it is beyond the financial means of most Municipalities to meet all the requirements of environmental acts right now.

Other Obstacles

There has been a significant shift in priority from the provision and reconstruction of basic necessities, such as sewer and water systems, to recreational, cultural, and other needs which had been regarded as optional, or at least of lower priority in former years. It seems this trend is continuing, and pressure from many sources exists for additional services at the municipal level, which were previously provided for by senior government or did not exist at all. This, of course, makes it more difficult to stress sufficiently the financial needs for basic infrastructure renewal. Eventually, significant and increasingly visible deterioration of the

infrastructure will, in itself, cause the public to shift its emphasis back to basic infrastructure renewal. By this time, costs will be much higher and the backlog much less manageable. We should not permit things to deteriorate that far before dealing with the problem.

Another obstacle being experienced throughout the western world is the desire by some authorities to develop standards and cost benefit criteria which would result in absolutely equitable and standardized treatments throughout a nation. The FCM study recommended that work begin on standardization, and this is a logical and generally desirable long-term objective, but one which will require a great deal of time. The rebuilding of our infrastructure simply cannot wait that long. Furthermore, it will not be possible to create realistic standards and priority criteria which will be completely, universally applicable. There exists a legitimate variation in acceptable services levels across Canada. Road and sidewalk service levels in Toronto can understandably be significantly different from those in Yellowknife, and some of this difference may legitimately be the result of local preference, as well as vastly different densities and volumes. If we are not careful, the quest for standards could seriously delay resolution of the infrastructure problem.

The obstacles to the solution of the infrastructure problem are understandable and part of our nature. They must, nevertheless, be overcome, and the sooner this happens, the easier it will be to cope with the problem. Continued delay will not make the problem disappear and, in fact, will permit deterioration to advance to the point where costs will be much higher. "A stitch in time saves nine" is certainly appropriate for this situation.

PROGRESS TO DATE

Having reviewed many of the reasons progress has been slow, it should be pointed out that some progress is being made. The following sections present an outline of this.

The infrastructure problem was recognized in the United States several years before it was in Canada. Accordingly, they are ahead in their attempt to deal with the problem. Although Canada's solutions may not parallel the American approach exactly, it is useful to review their progress, as it may give us some insite into what lies ahead for us.

Progress in the United States

a) Problem first identifed (1980-1983) in "needs" studies such as the American Public Works Association's "Revenue Shortfall"(5) and the National League of Cities' study "Infrastructure: An Initial Assessment"(6). The main purpose of these studies was to create public awareness of the problem and bring it to the attention of senior governments.

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(5) American Public Works Association Task Force on Revenue Shortfall, Revenue Shortfall, The Public Works Challenge of the 1980's, 1981.

(6) National League of Cities, Capital Budgeting and Infrastructure in American Cities: An Initial Assessment, April, 1983.

b) Senior governments then carried out their own studies e.g. those of the Congressional Budget Office and the Joint Economic Committee of Congress. These resulted in legislation being passed, such as the Public Works Improvement Act of 1984.

c) The Act then created a National Council on Public Works Improvement, which is currently reviewing the nation's infrastructure problem and has published its first report[7] in 1986. The Council will recommend action to the President and Congress when it has completed this work.

Although an infrastructure act exists in the United States, no actual Federal funding authorities have been set up. They are still in a study phase. In terms of physical works and provision of funding, at the Federal level in the United States there has been an increase in expenditures on highways and roads of 58% between 1982 and 1986, mostly due to a 5¢ gasoline tax increase. With regard to other forms of infrastructure, the latest information[7] shows a steadily reducing Federal input towards public works grants and similar programs.

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(7) National Council on Public Works Improvement, The Nation's Public Works: Defining the Issues, September, 1986.

Progress at the State and local levels has been more significant. States such as Washington, California, New Jersey, Connecticut, Oregon and Georgia have created a number of authorities to deal with infrastructure and set up trust funds in some cases which provide low interest loans for local public works projects. In Washington State for example, approximately $20 million per year is available for this purpose now. There is a continuing shift of responsibility from the Federal to the State and local levels. However, Federal assistance was never curtailed in the United States to the degree that it was in Canada, where it was essentially terminated.

At the local level, U.S. urban areas have instituted new revenue techniques such as user charges for streets so they could start coping with the infrastructure problem. Examples are Bellevue, Washington; Pocatello, Idaho; and Fort Collins, Colorado.

Comparable Progress in Canada

The Federation of Canadian Municipalities' study of infrastructure completed in 1984 is comparable to the first generation studies ((a) above), in the United States. There have been subsequent studies refining needs of various provinces and of various cities in Canada. No senior government studies comparable to those listed in (b) and (c) above, which would be aimed at direct senior government legislation have been published in Canada, although the Department of Public Works has recently been making surveys which suggest

(b). The FCM and several provincial governments have asked for Federal involvement, but this has not been achieved to the degree it has in the U.S. There are no proposals for Federal legislation comparable to the U.S. Public works Act. There is no Federal gasoline tax earmarked for infrastructure renewal.

Discussions have been held in Canada between FCM committees and Federal departments such as Transport and also Employment and Immigration. The purpose was to make existing funding in these Ministries more available for infrastructure purposes. Some regulations have been altered to facilitate this, but a recent review of cities across Canada shows it is still extremely difficult to qualify for and use existing employment programs for infrastructure renewal because of complex regulations aimed at creating employment in target groups. Thus, little of the money available in Federal employment programs is being used for infrastructure renewal. More cooperation is possible in this area and should be provided.

At the Provincial level, agreement was reached amongst Provincial Ministries of Municipal Affairs to support the essential elements of the FCM proposals on infrastructure and to advance these collectively to the Federal Government. Since FCM proposals are for equal sharing amongst the three levels of government, Provincial support is a significant step towards funding resolution, particularly since Provincial support is essential to convincing the Federal government to participate.

Another major step that has occurred at the Provincial level is the decision by the Province of Alberta to make its Provincial capital grants available for infrastructure rebuilding as well as for new construction, which was the previous sole purpose. Cost sharing under this program with Alberta municipalities is 75% Province and 25% local government, and significant funding is available for the programs. The Province has also made changes in its "municipal partnership for local employment programs" to permit lower interest loans to municipalities. More details on these programs will be given in other papers at this conference. For now, these changes can be considered similar in significance to those taking place at the State level in the United States.

The Province of Ontario has just agreed to pay half the cost of municipal studies to halt deterioration of watermains and sewers. A fund of $2.5 million has been set aside for this. Ontario is also prepared to provide contributions for water and sewer rehabilitation and is currently attempting to get matching Federal funds.

At the local municipal level, there has been recognition of the infrastructure problem and a shift in priority and emphasis towards infrastructure renewal has occurred. In recent years, Ontario municipalities have been carrying out infrastructure works which exceed available Provincial cost sharing programs and necessitate expenditure of 100% local dollars. Regina has provided funding for "catch-up" works. Edmonton has had a significant shift in

emphasis towards infrastructure renewal, partly assisted by the current economic conditions which work against new construction. Vancouver has had a successful plebiscite specifically for infrastructure renewal, but this is restricted for use only if Federal and Provincial sharing materializes.

In summary, progress towards infrastructure renewal in Canada has been greatest at the local level. There is general support at the Provincial level with one province having programs in place which compare favourably with U.S. States. Several other Provinces have improved their programs also. At all levels of government, especially the Federal level, progress is behind that in the United States. Not only is there need to do more at each government level, but more work is necessary to establish a coordinated approach to solving the problem involving all levels of government.

SUMMARY

The infrastructure problem in Canada is not catastrophic, but it is very significant. It must be dealt with soon, or deterioration and backlogs will grow to the point where many municipalities will be unable to cope with the funding needs. That is how people and cities go broke - slowly. Costs are manageable if all levels of government pitch in. In fact, if the problem is addressed soon, and with cooperation on everybody's part, cost increases over current expenditure levels will not be that large.

These necessary works are labour intensive and can reduce unemployment, thereby giving a boost to the economy. Infrastructure renewal can also improve the competitiveness of business and industry, thereby creating economic activity and additional government revenues. To reduce cost, there is a need to reassess our priorities and stress the more fundamental needs over those that are desirable, but less essential. There is also a need to eliminate waste or at least reduce it by making it clear to the urban public that extravagant and inconsistent treatments are just not affordable. More rapid and consistent decision-making by government would assist as well. There is also a need for legislation similar to that in the United States for dealing with funding for infrastructure correction on a nation-wide and consistent, rational basis. Of course, this is difficult to achieve at times when huge government deficits have been built up, and every attempt is being made to reduce these. However, deficits can also be reduced by revenue increases resulting from infrastructure renewal, as well as by expenditure reductions.

Most of all, the problem needs the coordinated attention of the Federal, Provincial, and Municipal governments acting in concert. There is a tendency in this direction, but it is much too slow. Buck passing and reluctance to assume responsibility are obstacles to the solution of the problem, which must be faced and resolved.

Can we solve this problem? Certainly; if we work together. But that's the hard part - working together.

APPENDIX

Condition of Canadian Urban Infrastructure

The majority of survey responses indicate that an infrastructure problem exists in Canadian urban areas. This supports the conclusions of the Mayors' pre-survey. Different types of infrastructure are in different states of adequacy. This is illustrated in Diagram 1.

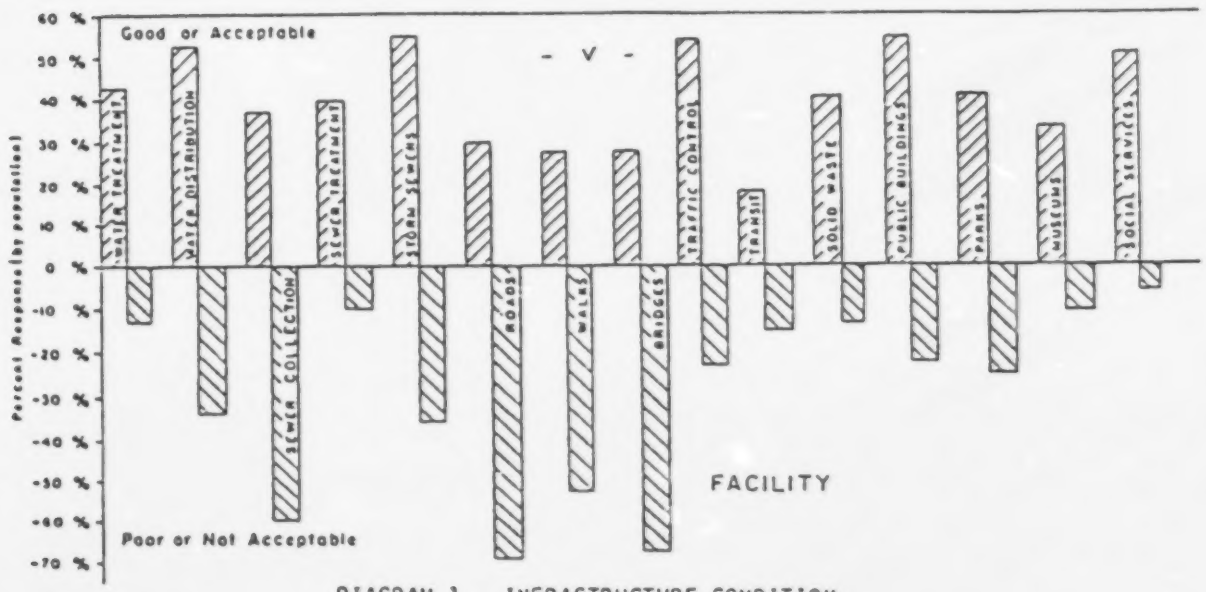

DIAGRAM 1 - INFRASTRUCTURE CONDITION

As with the Mayors' pre-survey, roads are identified as being in the greatest need of attention by 70% of respondents. Sidewalks, bridges and sanitary sewage collection systems are also identified as problem areas by the majority of respondents. More than half of respondents felt public buildings, water distribution sytems, traffic control facilities and storm sewer systems were in good or acceptable condition and the majority of respondents felt parks, solid waste facilities, water treatment systems and social service facilities such as day-care centres were in good or acceptable condition. It should be noted that Diagram 1 pertains to condition of existing facilities. The survey did not attempt to determine whether there was a need for more roads or more social service facilities.

CONCLUSIONS AND RECOMMENDATIONS OF THE FCM

1) A significant decline has occurred in the condition of infrastructure in Canadian urban areas. Steps should be taken to halt that trend.

2) The costs to bring the most seriously deteriorated forms of infrastructure (sewer, water, road and bridge systems) back to acceptable levels are high. Even when spread over a 10 year recovery period, these costs will represent an increase in current public works budgets of about 25%.

3) Additional local government funding sources should be found to help solve the revenue shortfall problem identified.

4) To raise the required funding is beyond the ability of many local governments and some assistance from other levels of government is required.

5) Better information systems should be developed, particularly in smaller municipalities, to permit better management of infrastructure systems and more effective use of available funding. Lack of information was a frequent reason given for not completing the survey questionnaire.

6) Greater interchange of information between Canadian municipal officials should be achieved through strengthened national associations and the publication of manuals on management practices.

7) To achieve a greater degree of national consistency in levels of infrastructure service, work should begin on the setting of service standards. This should be done in concert with the USA and European countries who are currently working on these. This is a long term effort and rebuilding of infrastructure should not await its completion.

8) Methods should be investigated which would reduce waste and excess costs due to delays and other impediments to reconstruction and maintenance of infrastructure.

9) Without jeopardizing the provision of new facilities needed to meet growth, a greater emphasis should be placed on maintenance and reconstruction as opposed to new construction, especially in Federal programs which might be developed in the future. This would extend the life of existing facilities.

10) Local governments should re-examine priorities so that the most essential basic services are emphasized during times of severe restraint. If this is not done, the economic health of our urban areas may be jeopardized and, with it, the other services as well.

11) Policies should be set by the FCM which could form the foundation and guidelines for recovery. The FCM should direct its Task Force on Urban Infrastructure, through its Technical Committee, to outline specific policies.

12) Programs should be established to begin implementing these policies and to deal with the reconstruction of the deteriorated forms of infrastructure over the next 10 year period.

13) An intergovernmental partnership should be established which would bring the combined and cooperative efforts of the three levels of government to the solution of the infrastructure problem. The opportunity exists to reconstruct our urban infrastructure, to make our urban areas more competitive, to strengthen Canada's economic recovery and, at the same time, to employ large numbers of Canadians in these labour intensive works.

14) National priorities may need adjustment to recognize that Canada is becoming an increasingly urbanized nation. It is in our urban areas that most Canadians live and it is here that our greatest problems are developing.

15) Public awareness of the infrastructure problem should be increased to obtain public support for necessary remedial measures through the wide dissemination of this report and other means available to the FCM.

16) The FCM should direct its Task Force, through its Technical Committee, to proceed with Phase II of this study in order to crystallize policies and outline programs necessary for corrective action in cooperation with other levels of government where necessary.

17) Estimated costs of Phase II are $50,000. Funding should be provided for this purpose.

SUMMARY OF RECOMMENDATIONS

FROM ALL SECTORS

AGRICULTURE AND FOOD PROCESSING

PRIMARY AGRICULTURE
- ROLE OF AGRICULTURE CANADA
- VERY SMALL AVAILABLE LAND BASE

SECONDARY MANUFACTURE
- POTENTIAL GROWTH AREA

FOOD PROCESSING
- POTENTIAL GROWTH AREA

RECOMMENDATIONS

- INTERFACE WITH BIOTECHNOLOGY
  - DISEASE CONTROL
  - GENETICS
  - WASTE MANAGEMENT
- VALUE ADDED
  - FOOD PROCESSING
- INCREASE PRODUCTIVITY
- INCREASE INDUSTRY INVOLVEMENT
  - CO-OPERATIVE RESEARCH

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AGRICULTURE AND FOOD PROCESSING

RECOMMENDATIONS (CONT'D.)

- FUNDING FOR SECONDARY MANUFACTURE, FOOD PROCESSING
- RESEARCH ORGANIZATIONS STAFFING AND EQUIPMENT
- GENERAL AWARENESS
- TECHNOLOGY TRANSFER

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AQUATIC RESOURCES

$750M INDUSTRY

AQUACULTURE - HIGH GROWTH
- SCIENCE ISSUES

RECOMMENDATIONS

- WATER QUALITY
  - SPECIFIC CONTAMINANTS
  - AQUACULTURE
- AQUATIC INSTRUMENTS AND DEVICES
  - INTERFACE WITH SECTOR
  - GROWTH AREA
- FISH HARVESTING
  - GOVERNMENT AND SOCIAL POLICIES
  - IMPROVEMENTS POSSIBLE
  - SHIP/SHORE COMMUNICATION

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AQUATIC RESOURCES

RECOMMENDATIONS (CONT'D.)

- FISH PROCESSING
  - NEW PRODUCTS
  - BY-PRODUCTS
  - QUALITY
  - PACKAGING
- AQUACULTURE
  - INTERFACE WITH BIOTECHNOLOGY
    - DISEASE CONTROL
    - NUTRITION
    - GENETICS
    - WASTE MANAGEMENT
  - NETWORK OF EXCELLENCE

BIOTECHNOLOGY

EMERGING INDUSTRY - $12M

IMPACTS ON MANY SECTORS - FORESTS
- AGRICULTURE
- AQUACULTURE
- HEALTH
- WASTE MANAGEMENT
- MINING

NEED FOR STRATEGIC PLANNING, CO-ORDINATION

RECOMMENDATIONS

- FOCUS ON
  - DISEASE CONTROL
  - GENETIC IMPROVEMENT
  - WASTE MANAGEMENT

- STRATEGIC PLANNING - USE OF EXISTING COMMITTEE

- LONG TERM COMMITMENT OF FUNDING

- RAISE FUNDING FROM $10M TO $30M - 5-10 YEARS

BIOTECHNOLOGY

RECOMMENDATIONS (CONT'D.)

- STRATEGIC RESEARCH, TRAINING, SCHOLARSHIPS
- INDUSTRY/UNIVERSITIES INTERACTION
- REVIEW FACILITIES NEEDS AND CO-ORDINATION

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ENERGY

MAJOR RESOURCE OF PROVINCE

DEPENDENCE OF OTHER RESOURCE SECTORS

OIL - IMPORT TO B.C.

NATURAL GAS SURPLUS

RECOMMENDATIONS

- OIL & GAS
  - DEVELOP UNDERSEA ROBOTICS
  - PREPARE FOR SWITCH AWAY FROM OIL
  - NATURAL GAS DIESEL ENGINE CONVERSION
- COAL
  - DEVELOP CAPABILITY TO ANALYZE COALS
  - BENEFICIATION & TRANSPORTATION
  - ALTERNATIVE USES

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ENERGY

RECOMMENDATIONS (CONT'D.)

- WOOD RESIDUE AND BIOMASS
  - CONTINUE DEVELOPMENTS - METHANOL, ETHANOL
- OTHERS
  - HYDROGEN
  - FUEL CELL

SCIENCE & TECHNOLOGY ENERGY FOCUS

- CENTRE FOR ENERGY STUDIES
- BUILD EXPERTISE
- UNDERTAKE TESTS
- NATURAL GAS
- LONGER TERM ITEMS

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FORESTS AND FOREST PRODUCTS

GROWTH AREA

MOVING TO VALUE ADDED PRODUCTS

RESOURCE DIMINISHING AND MORE EXPENSIVE

WORLD-WIDE COMPETITION

DEPENDENCE ON SCIENCE & TECHNOLOGY

ADVANCED MACHINERY AND SYSTEMS

PEOPLE NEEDS

RECOMMENDATIONS

- OVERALL CO-ORDINATION FOR SCIENCE AND TECHNOLOGY
- ADD VALUE
- IMPROVE PRODUCTION FOR RESOURCE

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FORESTS AND FOREST PRODUCTS

RECOMMENDATIONS (CONT'D.)

- RAISE TECHNOLOGICAL AWARENESS AND COMPETENCE
  - RESEARCHERS
  - 'RECEPTORS'
- TECHNOLOGY TRANSFER
- USE OF ADVANCED SYSTEMS, TECHNOLOGIES AND MACHINERY

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INFORMATION TECHNOLOGY

$1 BILLION INDUSTRY

11,500 PEOPLE

25%-50% ANNUAL GROWTH

RESOURCE INDUSTRIES/INFORMATION TECHNOLOGY

PEOPLE NEEDS

CO-ORDINATED ACTIONS

RECOMMENDATIONS

- ENHANCE RESOURCE INDUSTRIES BY ENHANCING THE INFORMATION TECHNOLOGY INDUSTRIES
- COMMIT TO INFORMATION TECHNOLOGY
- MARKETING, MANAGEMENT, TECHNICAL PEOPLE
- CO-ORDINATION AND PLANNING ROLE
- INFRASTRUCTURE AND SUPPORT

MANUFACTURING

IMPORTANCE TO PROVINCE

4,000 COMPANIES - 40 LARGE

LACK OF TRAINING

DIFFICULTIES OF LOCATING PARTNERS

TECHNOLOGY TRANSFER - SMALL COMPANIES

RECOMMENDATIONS

- STRATEGIC PLAN - 'CHAMPION'
- BIOMEDICAL DEVICES
- EDUCATION AND TRAINING
- TECHNOLOGY CENTRE
- RESOURCE INDUSTRIES - ROBOTICS
- NETWORKING
- CAD/CAM
- FUNDING

MINING, MINERALS, METALS

NEEDS

- INDUSTRY INVOLVEMENT
- NATIONAL CO-ORDINATION
- FOCUS ON R&D
- RAISING AWARENESS

RECOMMENDATIONS

- R&D CO-ORDINATOR FOCUSSED ON B.C. NEEDS, NATIONAL INTERFACE
- INDUSTRY CHAIRS - ADVANCED MATERIALS
- CENTRES OF EXCELLENCE:
  - ADVANCED MATERIALS
  - INDUSTRIAL MINERALS
  - GEOLOGICAL EXPLORATION
  - RARE & PRECIOUS METALS

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EMERGING THEMES

- BUILD ON EXISTING COMPANIES, ORGANIZATIONS AND INDIVIDUALS
- ORGANIZED STIMULATION OF INTERACTION AND PLANNING WITHIN AND BETWEEN SECTORS
- RESOURCE INDUSTRY FOCUSSED, TECHNOLOGY DRIVEN CENTRES OF EXCELLENCE
- VALUE ADDED PRODUCTS FROM RESOURCES USING TECHNOLOGY DEVELOPED IN B.C.
- DEVELOP THE MARKETING, MANAGEMENT AND TECHNICAL TALENTS OF OUR PEOPLE
- EFFECTIVE USE OF SIGNIFICANTLY MORE R&D SPENDING

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